March 11, 1987

NASA ADVISORY COUNCIL

Report of the Task Force on Issues of a Mixed Fleet

National Aeronautics and
Space Administration

National Aeronautics and
Space Administration

Washington, D.C.
20546

Reply to Attn of LB

March 11, 1987

Honorable James C. Fletcher
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Jim:

With your approval, the NASA Advisory Council established a Task Force on Issues of a Mixed Fleet to undertake an independent study of the principal issues associated with the employment of a mixed fleet of launch vehicles. The key questions addressed related to an appropriate mix of Space Shuttle and expendable launch vehicles, policies and practices for their use, and NASA's role in commercializing launch services. The Task Force has now completed its study and its conclusions and recommendations, strongly endorsed by the Council as a whole, are contained in their report, enclosed here.

Jasper Welch, who chaired the Task Force, has discussed the principal conclusions and recommendations with you, and Dale attended the Council meeting at which they were reviewed. I believe these are substantive conclusions and recommendations that warrant your careful attention. There have been enough good words on the value of a mixed fleet for NASA. We must now translate policy into action. The Council urgently recommends that NASA begin immediately, through a request for a supplemental budget, to provide sufficient ELV launch capability or service to achieve the robustness required for an effective space program. Without action now, the Nation's civil space program--especially that in space science, which has till now been a shining example of U.S. space leadership--will be damaged to a degree from which recovery will be extremely difficult and expensive.

Jasper and I stand ready to assist you in any way that we can, as do all the members of the Council.

Sincerely,

Dan

Daniel J. Fink

Enclosure

FINAL REPORT

NAC TASK FORCE ON ISSUES OF A MIXED FLEET

MARCH 1987

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March 11, 1987

INTRODUCTION

The issues addressed to the NAC Task Force on Issues of a Mixed Fleet included three principal thrusts: 1) What is an appropriate mix of Shuttle and Expendable Launch Vehicle (ELV) services for NASA? 2) What are appropriate policies and practices for NASA to use in planning and providing launch services? and 3) What role should NASA play with respect to current efforts to promote further commercialization of space launch services? Appendix A contains the statement of issues in its entirety.

Many of the same issues and questions were being addressed in a parallel study by the NASA Office of Space Flight (OSF) Mixed Fleet Study Team. During the course of its deliberation, this Task Force received progress reports from the OSF study team, and was provided ample opportunity to comment on their findings. At the Task Force meeting held on 12 January 1987, the panel received a comprehensive briefing on the final OSF study results, as presented to the NASA Administrator.

It is the view of this Task Force that the NASA-OSF study has resulted in an exceptionally thoughtful, comprehensive, well-coordinated plan, which has addressed many of the detailed questions (in Appendix A) posed to the Task Force. The Task Force members endorse the "Key Conclusions" and "Recommendations" contained in OSF briefing dated 12 January 1987 (reproduced in Appendix B). However, some important reservations related to provisions for unscheduled delays in manifest planning remain; these are discussed in detail below.

The endorsement of the OSF study results has allowed this report to focus on the broader policy and "strategic" planning issues to be addressed by NASA as the Nation undertakes those actions necessary to re-establish a robust, resilient launch capability.

NATIONAL OBJECTIVES

It is imperative that the Nation's space program make essential contributions to national security, space science and technology, space exploration, commercial applications, and industrial strength. The space program should also be a source of pride for our citizens and a key contributor to our international prestige.

The U.S. space program is being challenged as never before. Europe, China, and Japan all have vigorous, expanding space programs. The Soviet Union is making its immense, long-standing space effort much more appealing and visible. It has offered space launch services at rock bottom prices with favorable arrangements, as it seeks to exploit the Western hiatus in space launch activity. It is strongly encouraging more scientific cooperation and collaboration with Western scientific institutions.

This Task Force believes that an infusion of new direction, dedication, and commitment is demanded if the U.S. space program is to remain competitive. Addressing this new level of international competition will require the commitment of additional financial, technical and managerial resources. NASA itself must be diligent in making every dollar count toward mission accomplishment. But there is no escaping the depletion of scientific and technical capital that has accompanied years of chronic underfunding.

NASA has recently confirmed its goals to achieve major advances in aeronautics, space science, and exploration of the solar system. These are worthy national goals for the civil space program, and are clearly NASA's responsibility. A robust launch capability is an essential prerequisite for these space goals.

Robustness, the "sine qua non" of space transportation, is measured by 1) the adequacy and sustainability of the launch rates, 2) the capacity provided to accommodate uncertainties and unpredicted requirements, 3) the ability to recover rapidly from stand-downs, and 4) the capability to launch a diversity of spacecraft including large and heavy payloads. A successful program must be managed to meet each of these requirements.

The Task Force believes that a robust program must include 1) adequate amounts and diversity of flight hardware and spares, 2) enough launch and integration facilities to absorb unexpected, but inevitable delays, 3) continuing development to improve reliability, reduce operating costs and increase capability, and 4) realistic planning and scheduling that faces up to the potential for delays and stand-downs.

The Task Force is immensely sobered by the enormous budgetary costs, opportunity costs and program disruption of the current unplanned for stand-down. The units are billions of dollars. This cost and disruption overshadows, in our view, the previous custom of evaluating launch services on a "cost-to-orbit-if-everything-works" basis.

SITUATION ASSESSMENT

The comments that follow relate only to the Task Force's assessment of NASA's recovery plans and projected sustained space flight operations performance. The circumstances leading to the current shortfall in launcher availability were not addressed.

The Task Force assumed continuation of the current policy that divests NASA of any responsibility to provide launch services for commercial communications payloads.

As discussed below, this Task Force recommends that NASA planning be based on a Shuttle operational flight rate of about 12 flights per year from KSC. However, this 12 per year should be a "robust 12" and will absolutely require a replacement orbiter, more spares and the best effort of good people.

Furthermore, the Task Force recommends that every effort be made to off-load payloads onto Expendable Launch Vehicles, ELVs. The off-load to ELVs in the near future is significant beyond just the increase in payload launched to orbit by ELVs. The OSF study found that high use of ELVs improved schedules for many, many payloads by two to four years, both for payloads that wound up on ELVs and those on Shuttles.

The OSF study reveals that, with these assumptions of 12 STS flights per year and high ELV use, the shortfall in launch capacity for NASA's missions, including the remaining support to the DoD, is approximately 7-8 equivalent Shuttle flights (11 percent) for fiscal years 1988 through 1992.

This shortfall in capacity remains in spite of 1) the termination of NASA's commercial launch activities, 2) the abandonment of 28 equivalent Shuttle payloads previously programmed for space science, exploration and applications, 3) the delay of the remaining science and applications projects by an average of approximately 3 years, 4) the diversion of many DoD spacecraft to Air Force ELVs, and 5) the off-loading of all ELV compatible non-DoD payloads to ELVs.

Furthermore, and perhaps most importantly, the analyses of the OSF study have assumed no Shuttle or ELV operational problems resulting in extended precautionary stand-downs for analysis and/or modification. Also, the assumptions concerning Shuttle cargo bay loading efficiency represent substantial improvements over historical performance.

The capacity deficit for the three-year period 1993 through 1995 grows to 15-16 equivalent Shuttle Flights (24%), indicating a deteriorating situation. This is, of course, partly a result of the Space Station construction and operational support demands.

Current OSF planning for the 1994 and following period calls for eight Space Station support flights plus four flights per year for Shuttle unique national security payloads. This would fill a 12 flight STS manifest, leaving no additional capacity for other missions, including non-Space Station science, on-orbit servicing, repair, re-boost and launch of new spacecraft.

The Task Force views this shortfall with measured but real alarm. The real requirements of the Space Station are being frozen by design decisions this year. Unlike a manifest of disjoint payloads, the Space Station launch demand comes as a single, very large requirement. Moreover, choices between Shuttle and ELV launch are being made this year for many post-1993 DoD payloads. Serious effort by NASA is clearly required in 1987 to resolve the post 1994 supply and demand for the Shuttle.

The Task Force believes that the science and exploration programs deserve special attention in the deliberations that lie ahead. They are at the heart of NASA's mission. They are spelled out in

NASA's charter. There is no one but NASA to ensure a healthy program. Space science and exploration provides a large measure of popular support for the space program as a whole. Substantial private and state government investments have been made in the research institutes that conduct these programs. The federal government has a fiduciary responsibility to these investments and to support the goals for which they were made.

FLIGHT RATE PLANNING FOR SHUTTLE

This Task Force did not make any independent inquiry into the achievable flight rate of the Shuttle. It notes that:

(1) The recent National Research Council study concluded that 11 to 13 flights per year is the reasonable upper limit expectation with four Orbiters;

(2) The NASA in-house planning with four Orbiters spans the range of 12 to 16 flights per year as the asymptotic rate through to 1995;

(3) The Shuttle payload weights are being adjusted downward to accommodate "down weight" requirements; and

(4) The rates in (1) and (2), above, assume no major disruption or fleet-wide stand-down.

The Task Force well understands that there are fixed annual costs associated with the STS operation. This has led many to conclude that, therefore, economics dictates that the Shuttle should be launched as often as possible in order to minimize per launch costs.

This Task Force does not share that judgement. Rather, we place primary importance on the enormous costs that are imposed on a (helpless) user community by delays in planned for launch dates. The post-Challenger stand-down has dramatized these delays, but we would draw attention to the fact that delays were common and expensive, even without such a major disruption.

That is, The Task Force believes that true economy would be achieved by 1) investing sufficient resources in the Shuttle to be able to support planned launch rates even if there are delays and precautionary stand-downs and 2) establishing planning criteria and processes that realistically deal with the high probability of unscheduled delays.

Following this philosophy, we recommend that the expected Shuttle flight rate be taken as a "robust 12" flights per year. This means 1) spares, facilities and other resources must be sized to accommodate 16 flights per year over a two to four year planning

horizon, 2) launches are not promised at a rate faster than 12 flights per year, and 3) both payload and launch preparation be structured to stay ahead of schedule so that inevitable, unexpected delays with one mission can be handled without impacting other programs.

A flight rate of twelve is judged by the NRC study and OSF to be sufficient to keep the Shuttle operation vigorous. For the time period to the early 1990s there will be an adequate backlog of payloads to "supply" the Shuttle should rates above twelve prove comfortable to sustain.

But the thrust of the Task Force recommendation of providing a resource base for sixteen flights per year is to provide a surge capacity to 1) make up for periods when the baseline twelve was not achieved (miss one flight at a rate of 12 and it takes 10 months at 14 per year or 5 months at 16 per year to get back on schedule), 2) provide for "extra" flights to service or repair a satellite (e.g., re-boost of the Hubble Space Telescope will be needed on demand if the atmosphere is unduly heated at the next solar maximum), 3) provide insurance to protect space science missions which often require a very specific launch window for success, or 4) backup the ELV fleet if it has troubles.

CONSIDERATIONS GUIDING MIXED-FLEET POLICY

This Task Force believes that a robust space access program must include:

1. A launcher family that is diversified in size and type,

2. A manned launcher with two-way cargo and crew transfer capabilities,

3. Sufficient launch capacity in each launcher class to provide for continuing space operations during stand-downs for another launcher class,

4. Launchers with much larger and heavier payload capabilities than the Shuttle,

5. Sufficient capacity at launch and integration facilities to absorb unexpected, but inevitable delays without impacting other programs.

6. An aggressive launcher reliability improvement program,

7. A strong supporting logistic program for all launch elements, and

8. An aggressive policy of providing dual-launcher compatibility for high priority payloads.

The Task Force views the Shuttle as a critical national resource and an absolutely essential ingredient in the U.S. space program. Many space science missions are critically dependent upon the manned capability of the Shuttle. Furthermore, the Space Station program is clearly dependent on robust Shuttle support.

Therefore, the Task Force recommends a major evolution in NASA policy from one that has maximized the use of the Shuttle, to a policy that preserves the STS fleet for those critical missions that require its unique capabilities. These features include two-way crew transportation, manned on-orbit tasking and intervention, spacecraft servicing and reboost, and the ability to return cargo from space.

Inherent in this recommendation is the incorporation of a diversified family of expendable launchers in the NASA space flight program. Every effort should be made to transition cargo missions onto ELVs, even in cases where modification of the payload is required, in order to conserve the Shuttle for its prime mission, for which the Task Force sees plenty of demand.

While the Shuttle should not "compete" for cargo roles which do not require its unique capabilities, it should be available as a backup in the assured space access planning. In the future, high priority spacecraft should be designed for dual ELV or ELV-Shuttle compatibility, where technically and economically feasible. OSSA should also plan for a diversity of launchers and the use of dual-compatible spacecraft to assure continued access to space.

As indicated above, the Task Force recommends that manifest planning be based on a "robust 12" Shuttle flights per year, following the transition to full operational status. This recommendation assumes a 4-Orbiter fleet and a well-funded logistics program. To the extent feasible, all four Orbiters should include those special modifications required to support DoD missions--otherwise the DoD priority will likely force expensive delays onto other users.

Additionally, the planning and procedures should accommodate periodic stand-downs in each element of the ELV and manned fleets for problem analyses and resolution. Stand-downs (whether post-accident or merely precautionary) are extremely disruptive, costly beyond calculation, and represent the greatest single lien against achieving an adequate sustained flight rate. In-depth preparations are required to assure a rapid return to operational status following the identification of faults. NASA must emphasize recovery planning for all identifiable eventualities, including precautionary interruptions and accidents.

This panel recognizes that a major effort is underway to address the current Shuttle design improvements. Accordingly, it is

reasonable that the planning assume that future problems are not catastrophic. Furthermore, the STS program has benefited from what is probably the most comprehensive reliability program ever instituted for a U.S. launcher.

NASA must anticipate, nonetheless, that problems will arise in both the ELV and manned segments of the fleet that will require extended stand-downs. For example, the Titan III booster has achieved a launch reliability of approximately 95%, which is fairly representative of ELV performance by the major suppliers. Based on the 31 ELV flights now planned over the period through 1995, the probability of accident-free operations is only 28%. If the failure rates could be reduced by a factor of two, the probability of failure-free operation would increase to only 53%.

In the Shuttle case, if one assumes a probability of successful operation of 99.5% (a failure rate 1/10 that being experienced by typical ELVs), then the probability of flying the 83 projected operations through 1995 without requiring a stand-down for analyses and/or design modification is only 66%. More to the point, a program goal of well over 99% will inevitably lead to unscheduled precautionary stand-downs.

Clearly NASA planning and budgeting should anticipate some level of problem generation at the flight rate anticipated during the next decade.

We should anticipate that the manned elements will suffer longer delays for problem analysis and resolution than the ELV segments (perhaps 6 to 12 months, versus the historical 2 to 8 months for ELVs). From a management perspective, the integrated launcher fleet should be assumed to be continually in some level of "recovery" and work-around involving schedule planning and problem resolution. Maintenance programs and modifications to upgrade performance will also contribute to intermittent loss of availability for segments of the fleet.

These issues cannot be wished away. Worst of all, failure to prepare for them pushes unexpected costs--budgetary and otherwise--onto the users of space transportation. This user community does not have any practical way of enforcing such preparation onto the launch services community. Hence, we must place the primary responsibility onto the launch services community and, in turn, upon NASA top management.

It must be recognized that the Space Station will consume a large fraction of the Shuttle manifest by the mid-1990s. The STS role is clearly essential for many of the supporting flights because of the need for manned tasking and intervention, and requirements for two-way crew and cargo transfer. The Space Station is destined to provide a demanding test of the adequacy of Shuttle operational planning. NASA must take those steps required to assure its availability.

On the other hand, the Space Station planning must be revisited. The Station should not expect to routinely use the Shuttle for delivery of cargo to orbit, nor can it specify today its need for unexpected crew and cargo rotation, nor can it count on Shuttle operation without stand-downs. This is the year for the Space Station to develop realistic plans and designs to deal with these unavoidable uncertainties.

The Task Force recommends that, in order to further off-load the Shuttle, the DoD be urged to divert as many of the remaining payloads as possible to the ELVs. The OSF study shows that the DoD is requesting about 50% of the Shuttle manifest in the 1988-1992 planning period, and over 40% of the manifest in the critical 1993-1995 timeframe (assuming 12 flights per year). It is clearly not possible to provide this level of support while meeting Space Station demands plus the critical science requirements; e.g., servicing and reboost.

It is apparent, following detailed discussion of the Task Force with senior representatives from the major launch vehicle suppliers, that the industrial capacity for ELV boosters in the U.S. far exceeds the most aggressive requirements projections (after a 3- to 4-year recovery period). This Task Force would note that a systematic development program to increase the reliability of current ELVs would be beneficial. Now that there is the general recognition that ELVs are to be used over the long run, such programs should garner support.

SUGGESTED POLICY FOR NEAR-TERM PROCUREMENT OF ELVS

NASA should, of course, take maximum advantage of the DoD's Titan IV (CELV) and Delta II (MLV) procurements, as well as other "available" expendable launchers, to meet their total near-term requirements. In pursuing this course of action the Task Force is concerned with approaches that include "innovative procurement" such as "minimum oversight, launch services" and "joint programs" such as having the Air Force "buy ELVs for NASA." These may well lead to unnecessary delays and, ultimately, substantial extraordinary NASA management effort to execute an otherwise straightforward procurement of available ELVs.

Accordingly, the Task Force believes that NASA should contract directly with the suppliers selected by the DoD, rather than using the Air Force as a procurement arm. This is viewed as an important factor in assuring focused management responsibility at NASA and at the contractors. The cost benefits from the combined NASA/DoD orders should be retained and available to both organizations. This will require a negotiated set of common requirements, including documentation, inspection criteria, etc., in order to achieve the full potential cost savings.

NASA management of upper stage procurement is viewed as particularly critical, because of the close ties between the upper stage and the payload.

The Task Force strongly recommends that ELV procurement provide adequate capacity to ensure flexibility and responsiveness to stand-downs for the various launchers. This will also improve the availability of the Shuttle to support on-orbit contingencies and service requirements. This is of great importance to the Space Station and several science payloads.

This added capacity should not only include procurement of additional ELVs and appropriate logistical support, but also some form of "surge" capability--for example, through contractual options with incentive fees for early delivery.

The Task Force recommends that launch vehicle cost, while important, should not be the dominant criterion in the vehicle selection and planning processes. Launcher reliability and availability are clearly more important in light of the relative lower costs of launch services when compared with the costs of spacecraft procurement and mission operations. This is further emphasized by the huge costs imposed on user and launcher communities by an extended stand-down.

The Task Force strongly recommends that NASA retain its launch services and payload-upper stage integration management roles in the near-term, because of the urgency of flying the accumulated backlog of payloads. A change of management roles, even if desirable in the future, would inevitably lead to further schedule erosion in the next three or four years. The practice of contracting appropriate launch services and integration support to industry should be continued and, where possible, expanded.

The Task Force is concerned that recent launch planning assumes no launch or integration facility improvements or expansions. But a robust space transportation system must be able to accommodate precautionary delays of one vehicle and payload without impacting others. Accordingly, the Task Force recommends that a study should be performed on an urgent basis to assess the constraints imposed by the current complement of launch and integration facilities at the Eastern and Western Test Ranges. This must, of course, be convolved with the selection of ELVs for the overall NASA, DoD and commercial requirements.

This study should lead to an integrated NASA/DoD program to construct any needed additional facilities. The time and cost required to remove constraints imposed by facility limitations are clearly minimal, when compared with the program costs associated with launch delays. A budget place-holder should be inserted now.

The Task Force also recommends that a study of upper stages be undertaken to ensure that adequate attention is given to this element of planning. This study is, of course, highly dependent on the detailed launcher strategy, and, as such, should be an integral part of the overall space transportation planning.

LONG TERM MIXED FLEET CONSIDERATIONS

The Task Force takes note of the long-term trend toward larger and more complex spacecraft for communications, national security/defense and science. Not all spacecraft will follow this trend nor should they. But for certain missions the trend is strongly driven by cost relationships, as well as technical considerations. For many commercial communication applications, earth station operating costs, including data processing and dissemination, dominate spacecraft and launch costs and clearly favor supporting a smaller number of large payloads, rather than a larger number of small spacecraft. For science spacecraft, many will remain small, but the larger ones grow ever larger. This trend is probably irreversible and, to the first order, is not influenced by launch cost.

It should be noted that the larger, more complex payloads exacerbate the launch planning and scheduling problems, since they are more subject to development delays. They are also more likely to tie-up integration facilities while unexpected problems are being addressed.

A Heavylift Expendable Launch Vehicle (HELV), with a payload weight well in excess of the STS, will be required in the next few years, not only to accommodate cargo requirements exceeding STS capabilities, but also as an alternative and backup for the Shuttle to allow off-loading heavy payloads which do not require man's presence. Heavier loads to LEO would reduce the transit time for planetary probes to Mars and the outer planets to typically one year from the present three or more years--with attendant reduced mission costs.

An HELV program is attractive to the Task Force for these reasons:

1. Provides the size and weight needed by overall mission considerations.

2. Contributes to national prestige through its enormous lift capability.

3. Protects the Shuttle from missions requiring large lift, but not requiring Shuttle's unique capabilites.

The Task Force made no effort to recommend among alternative HELV approaches, but noted that a Shuttle-derived vehicle (SDV) would seem to offer the following features:

1. Adds a new expendable launch vehicle providing backup for Titan IV class payloads. The SDV would exhibit failure modes independent of other ELVs, and would largely avoid failure mechanisms associated with the Orbiter and its man-support subsystems.

2. Provides a major increase in throw-weight at a potentially modest cost and with a short development schedule.

3. Provides additional production of common-use Shuttle components, thus reducing Shuttle operational and procurement costs, while improving the spares inventories.

4. Contributes to the large cargo capacity required for Space Station construction, and on a compatible time scale.

5. Achieves substantial compatibility with the existing and planned Shuttle integration and launch facilities (a benefit and a penalty).

6. Addresses the trend toward very large spacecraft, perhaps an additional 30,000 lbs to LEO.

7. Benefits from an exceptionally comprehensive Shuttle reliability program.

8. Achieves lower operating costs by sharing launch crews and facilities with the Shuttle.

9. Allows Shuttle design modifications to be flown initially on the SDV without risking the crew. This could substantially accelerate the incorporation of design changes.

The Task Force recognizes that most designs for heavy-lift launch vehicles, including Shuttle-derived designs, are promoted as offering more economical cost-per-pound-to-orbit. Such claims are undoubtedly true. This potential is an added bonus. Our interest lies in the considerations set forth above, and we would recommend an HELV program even without the lower cost-per-pound-to-orbit.

For those who believe launch costs, narrowly defined, are pivotal, we would note that a short, less costly development program is more easily and more surely amortized than a longer, more costly one.

The Task Force, while making no recommendation relative to a specific HELV implementation, does strongly suggest that NASA

include a new heavy-lift vehicle in their planning. Furthermore, this panel feels that a Shuttle derivation deserves detailed evaluation and consideration.

The Task Force noted with interest that press reports indicate that the Soviet "mixed-fleet" planning includes a rich mixture of conventional ELVs, a "space shuttle" with a 30,000 KG payload capacity to LEO, plus a shuttle-derived HLV capable of boosting 100,000 KG into LEO. (Signal, December, 1986)

As one projects launcher requirements farther into the future, it is clear that an aggressive, comprehensive technology program will be required to ensure U.S. preeminence in high-end booster capability. The Task Force commends a model for NASA's consideration in which NASA assumes responsibility for sponsoring a broad research program which would be coupled to vehicle developments by NASA and the DoD to their own unique mission requirements. This is analogous to the current aeronautics modus operandi.

NASA-DoD COORDINATION

Budgetary constraints and schedule considerations will continue to demand extensive use of common launch systems for NASA and DoD missions. As NASA incorporates a significant ELV fleet into its program, a new level of collaboration with the DoD will clearly be required. The demands on the shared facilities at ETR and WTR are destined to strain the capacity at these key sites. Furthermore, as the nation contemplates the development of new boosters and upper stages, there will be increased emphasis on assuring their applicability to the needs of both organizations. This is an environment that could lead to a level of interagency competition that the Nation simply cannot afford. What is needed is a steadfast attitude of mutual trust and cooperation.

Therefore, this Task Force strongly recommends that the Secretary of Defense and the NASA Administrator develop and sign a Memorandum of Understanding (MOU). This MOU should define the relative roles, responsibilities and authorities of the DoD and NASA, at all organizational levels that interface in the development, procurement and management of common-use launch systems. In particular, the MOU should cover the conduct of launch operations, including the criteria to be used in designating the Mission Directors.

NASA's ROLE IN PROMOTING COMMERCIAL SPACE TRANSPORTATION

The Task Force heard presentations by representatives from a number of companies with commercial space transportation aspirations, as well as by senior officials from the various Government agencies involved with these activities. The panel was exposed to a remarkably wide range of views, considerations and planning maturity related to potential commercialization initiatives. This was coupled with an exceptionally diverse set

of definitions for what constitutes a "commercial" launcher and/or launch services activity.

Considerations that, in the opinion of the presenters, bear on defining the "degree of commercialization" include:

1. The ability of the supplier to negotiate a contract directly with the user, with Government intervention limited to regulatory roles.

2. The ability of the supplier to perform on the contract with essentially no Government involvement.

3. The degree to which the associated manufacturing is free from Government-imposed documentation and inspection requirements.

4. The degree to which the flight and ground-support hardware developments were financed by private sources.

5. The degree to which the associated contracts provide for a payload delivery into a specified orbit for a fixed price, with launch failure liability limited by the terms and conditions of the contract.

6. The degree to which third-party liability and payload indemnification insurance is provided by non-Government sources.

The Task Force chose, for the purpose of their deliberations and comment, the following definition for a commercial space transportation activity:

> "The direct industrial sale of launch vehicles and/or launch services to non-Government users, where the U.S. Government involvement is essentially limited to regulatory roles."

The Government, of course, has always procured launch vehicles and launch support from industry. The manner in which Government procurements differ from "commercial" purchases clearly relates to the "terms and conditions" incorporated in the contracts. The definition suggested above does not suggest that the Government cannot take advantage of the development of a commercial space transportation industry. This would be accomplished by modifying the terms and conditions of the contracts to more closely emulate those incorporated in their commercial counterparts (to the extent this is found to be in the best interests of the Government).

However, the Task Force strongly recommends that, in light of the enormous leverage launch operations have on overall program costs, NASA not increase the risk of launch failure by

significantly reducing their management oversight. As was noted above, launch costs are typically a small part of overall program costs, but the costs associated with program delays can be large. Moreover, the Government self-insures its own payloads and those science and applications payloads it sponsors at non-Government research entities. For such payloads the Government must assume a risk protective posture. Commercial payloads can, and do, provide their own payload insurance. The Government oversight role cannot be justified as insurance in these cases.

The Task Force believes that if a significant commercial space transportation industry were to develop in the near term, it would most likely germinate under one or more of the following circumstances:

1. Launchers or launch services developed under Government sponsorship being offered to non-Government users on an incremental cost basis (with appropriate Government approvals).

2. Launchers or launch services with very limited payload capability, developed with private financing, being offered on a strictly commercial basis to low-end users where launch costs are a pivotal consideration.

3. Launchers or launch services targeted on a specific application for which a major user, commercial or governmental, contracts upfront for a large enough initial order to justify a new launcher development.

The benefits potentially accruing from commercialization would appear to include:

1. A strengthening of the associated U.S. industrial base.

2. Reduced procurement costs for the U.S. Government, derived largely from increased manufacturing volume.

3. Minor improvements in U.S. balance-of-trade from associated foreign sales.

4. Increased industrial innovation in the areas of reliability and cost, as the participants address market competition.

5. Larger industrial investments to improve competitiveness and performance.

6. Enhanced national prestige, if the ventures flourish.

The penalties associated with an aggressive program to support the establishment of a viable activity in the private sector could include:

1. Exacerbation of launch pad and integration facility constraints in the near-term.

2. Increasing the potential for priority conflicts between Government procurements and their commercial counterparts, whose fixed-price structure may attract substantial corporate management attention.

The overall tradeoff would seem to favor stimulating commercialization, with appropriate attention being given to the risk issues.

The data presented to the Task Force indicate that the available launch services market, following fly-off of the current backlog, is likely to be relatively small and highly competitive. There is clearly excess capacity on a world-wide basis for payloads in the small-to-intermediate weight class. Foreign subsidization, "flexible" pricing and financing policies, and national prestige issues are among the factors complicating the marketplace. Furthermore, increasing requirements for foreign trade "offsets" and in-country participation are likely; all of these factors will make it difficult to achieve the benefits of scale. On the other hand, several of the current foreign boosters are experiencing reliability and availability problems, which may increase the potential U.S. participation in the market.

The Task Force supports a policy which allows U.S. industry to address those market segments which are found to be sufficiently attractive to warrant private investment. The Government should support this commercialization by incremental pricing of support activities (e.g., launch site support), and should permit and encourage the private sector to use relevant Government facilities. The Task Force views the current policy statements and negotiations with industry on these matters to be appropriate and encouraging.

This Task Force recommends that NASA neither encourage nor discourage the development of "system operators," whose role is to facilitate the interfaces among the commercial spacecraft or services contractor, the launch services contractor, the finance community and the insurance firms. If this industry is needed by the participants, it should be allowed to develop.

PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS

This Task Force believes that the reconstitution of a robust, resilient, flexible space transportation system deserves the highest national priority. Furthermore, it has concluded that NASA policy evolution, as well as major program initiatives, are required to achieve this objective.

The principal recommendations are summarized as follows:

1. The Shuttle must be recognized as a national resource of enormous importance to the U.S. space program. NASA policy should evolve from one that has maximized the use of the STS to a policy that preserves the Shuttle for those missions requiring its unique capabilities.

2. NASA should, on a most urgent basis, initiate a program to incorporate a diversified family of expendable launchers into its space flight program, to include a Heavy-lift ELV. Payloads should be off-loaded from Shuttle onto the ELVs wherever possible.

3. NASA planning should be based on a "robust 12" Shuttle flights per year, following the transition phase to full operational status. This recommendation is contingent on a 4-Orbiter fleet and a sound logistics program sized to support a "nothing-goes-wrong" surge rate of 16 flights per year.

4. NASA planning should be modified to accommodate unexpected, precautionary stand-downs for all manned and unmanned vehicle types. Sizing of ELV and STS procurements must reflect this realism. Additionally, NASA should develop a program to substantially accelerate recovery from stand-downs.

5. The Secretary of Defense and the NASA Administrator should develop and sign a Memorandum of Understanding (MOU), which defines the relative roles, responsibilities and authorities of DoD and NASA elements in the development, procurement and management of common-use launch systems.

6. A study should be initiated to evaluate the constraints imposed by the current complement of launch pads and integration facilities on launch rate, surge capability, absorption of delays, and accelerated recovery from stand-downs. The study should provide recommended actions to substantially alleviate any identified limitations.

7. A study should be undertaken to evaluate the robustness of the upper stage vehicle fleet to exploit fully the diversified launcher family.

8. The Government should encourage commercialization activities, but should not directly subsidize such developments.

APPENDIX A

CHARTER

NAC TASK FORCE ON ISSUES OF A MIXED FLEET

October 9, 1986

NASA ADVISORY COUNCIL

STUDY OF ISSUES OF A MIXED FLEET OF LAUNCH SYSTEMS

TERMS OF REFERENCE

Background

Formal statement of national policy on space launch vehicles is under development by the Administration. It appears, as a consequence of the Challenger accident and the reassessment of Space Shuttle capabilities, that the policy, when established, will include elements of the following:

- The U.S. national space launch capability will be based on a balanced mix of launch systems, consisting of the Space Transportation System (STS) and expendable launch vehicles (ELVs). The elements of this mix will be defined to support best the mission needs of the national security, civil government, and commercial sectors of U.S. space activities.

- The unique STS capability to provide manned access to space will be exploited in those areas that offer the greatest national return. The STS fleet will maintain the Nation's capability to support critical programs requiring manned presence and other unique STS capabilities.

- The DOD will develop and operate a complementary expendable launch vehicle (ELV) capability for national security missions.

- The U.S. will encourage and facilitate commercial ELV operations by: (1) procuring ELV services from the private sector when appropriate, (2) launching foreign and commercial payloads with the STS only when the payloads are Shuttle-unique or have national security or foreign policy implications, and (3) minimizing government regulation of commercial ELV operations.

NASA launch vehicle policy has evolved to follow national policy. NASA will conduct its space flight program with a mixed fleet, employing both the Space Shuttle and ELVs, depending on respective capability, schedule, or other special need. NASA will also cooperate with other responsible organizations to assure that the total U.S. space launch capability (both government and commercial) includes the needed complementary launch systems.

Issues Raised

The mixed fleet concept leads to fundamental issues that need to be addressed. Included are such questions as:

- o What is the proper mix of Shuttle and ELVs for the present NASA program and that planned for the next several years?
  - What criteria should be used for selection of launch systems for NASA missions: capabilities, schedules special factors such as need for human, Centaur, RTGs?
  - What mix of Shuttle and ELV missions does this yield for the NASA flight program (with allowance for Shuttle flight of required DOD payloads)?
- o How is a "commercial ELV service" defined? What is the extent of the service? How are specifications set and met? What arrangements must be made for the use of government-owned facilities? What additional requirements must commercial operators meet, such as insurance, safety, etc.?
- o What is the likelihood of being able to acquire from commercial sources the full NASA-required ELV capability necessary for the mixed fleet activity?
  - What must NASA do to stimulate a viable U. S. commercial ELV industry? Is some form of support required? What are the different modes of support that NASA--and the government--could employ for the industry?
  - How can a private U.S. ELV industry compete internationally with foreign government-subsidized launch systems?
  - How can a private U.S. ELV industry meet the full set of requirements (e.g., liability, safety, etc.)?
  - What is the relationship of the DOD and its program for complementary ELVs to a commercial ELV industry? Will this be an appropriate model for NASA? If not, what is a good model for the NASA's relation to an ELV industry?
  - If other departments and agencies are involved in stimulating a commercial ELV industry (DOT, DOC), how should NASA interact with them?

- o If a private ELV industry is not viable, how should NASA work to assure the necessary U.S. launch capability for both government and commercial payloads?

The purpose of this study is to examine these and other relevant questions and develop recommendations for NASA actions.

Task Force and Membership

The NAC Informal Task Force for the Study of Mixed Fleet Issues is established to conduct the Study. The Task Force is to be chaired by Jasper Welch, at-large member of the NASA Advisory Council. Members and staff are listed in the enclosure.

Schedule

The study will be conducted beginning in October 1986, and should be completed by about February 1, 1987. A final report should be submitted to the NASA Advisory Council for its consideration prior to its February meeting.

Cost

It is anticipated that the conduct of the study will cost about $10,000, all in travel funds for the travel and subsistence of members.

APPENDIX B

NASA MIXED FLEET STUDY

CONCLUSIONS AND RECOMMENDATIONS

OFFICE OF SPACE FLIGHT

NASA MIXED FLEET STUDY

SUMMARY

KEY CONCLUSIONS

- MIXED FLEET REQUIRED
- NASA LAUNCH CAPABILITY NOT ROBUST EVEN WITH HIGH ELV OPTION

OFFICE OF SPACE FLIGHT

NASA MIXED FLEET STUDY

RECOMMENDATIONS

POLICY

- ASSURE ACCESS TO SPACE
- UTILIZE MIXED FLEET TO:
  - -SUPPORT NASA MISSION REQUIREMENTS
  - -PROVIDE DUAL LAUNCH CAPABILITY FOR CRITICAL PAYLOADS
  - -EXPAND NATIONAL LAUNCH CAPABILITY
  - -PROTECT SHUTTLE FLEET -- A NATIONAL RESOURCE
  - -FOSTER ELV COMMERCIALIZATION

SPECIFIC

- IMPLEMENT "HIGH ELV" MIXED FLEET OPTION (FOR PAYLOADS THROUGH 1992)
  - -GENERATE EXTERNAL SUPPORT (e.g., OMB, CONGRESS, SIG)
  - -PREPARE BUDGET SUPPLEMENTAL / AMENDMENT
- FORMULATE MIXED FLEET IMPLEMENTATION PLAN
- ASSURE SAFE SUSTAINABLE SHUTTLE FLIGHT RATE